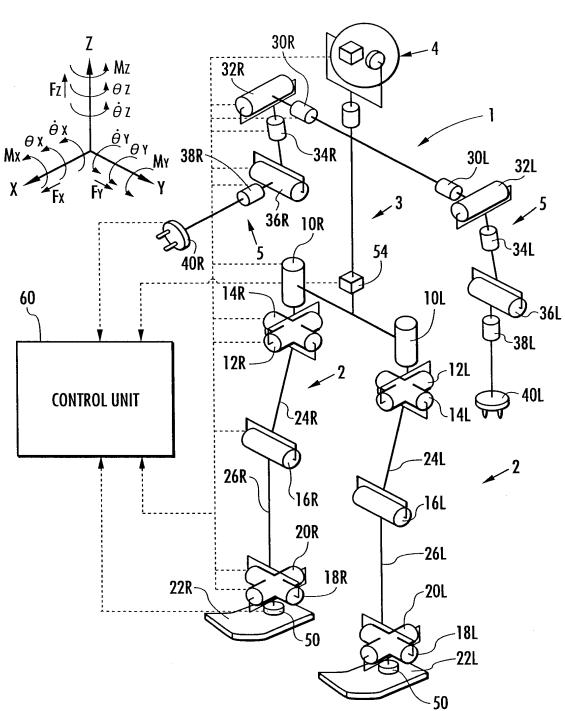
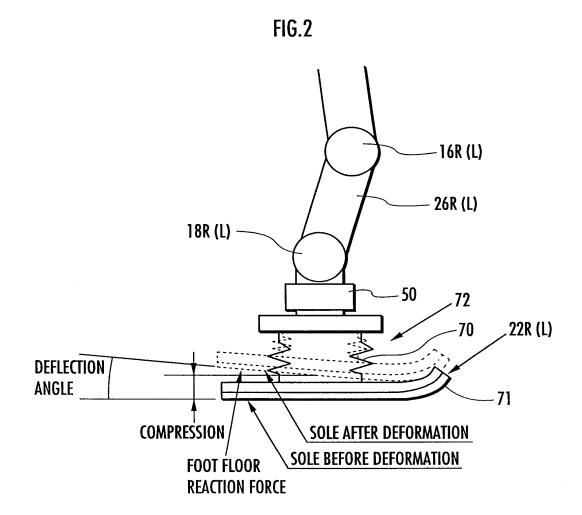
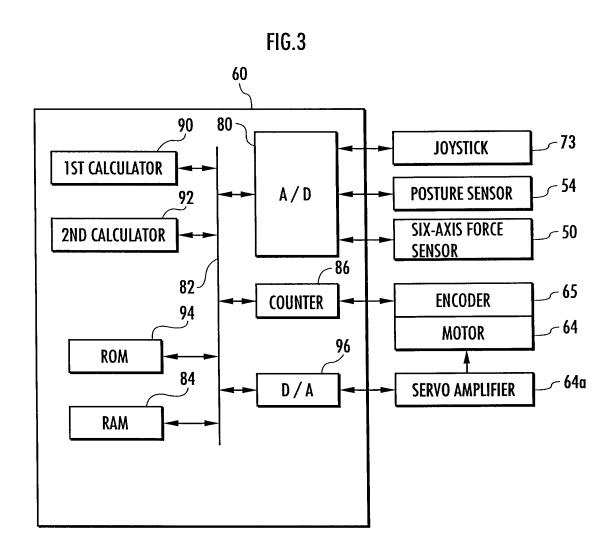
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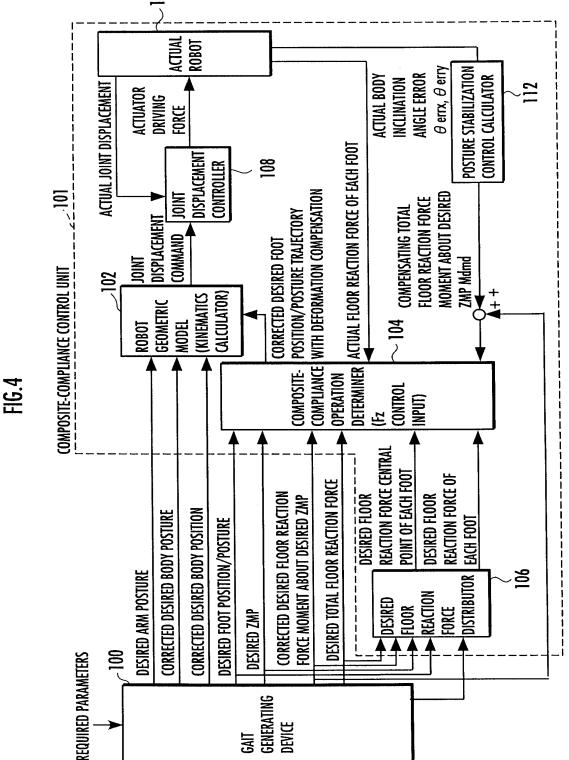
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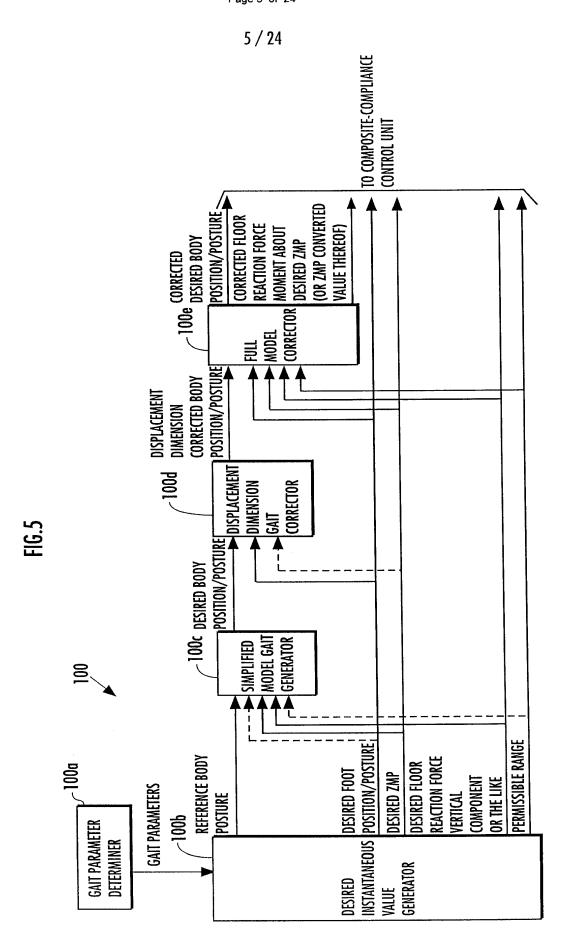






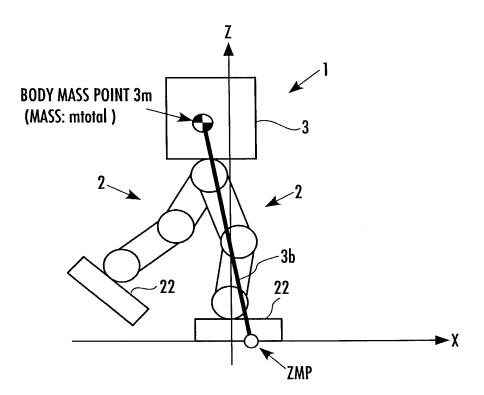
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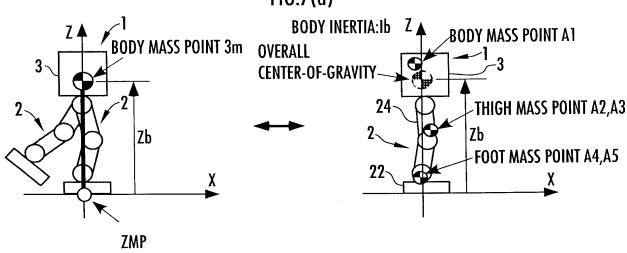
FIG.6

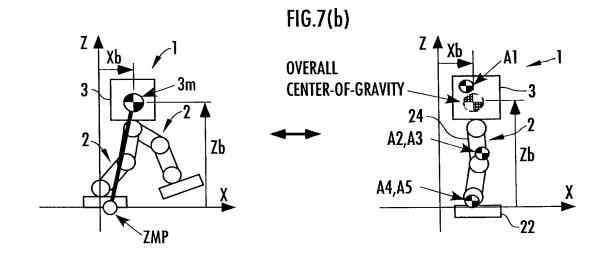


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# FIG.7(a)





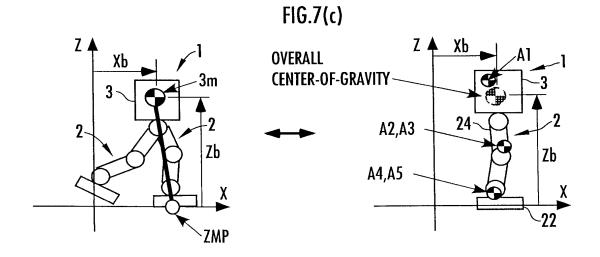
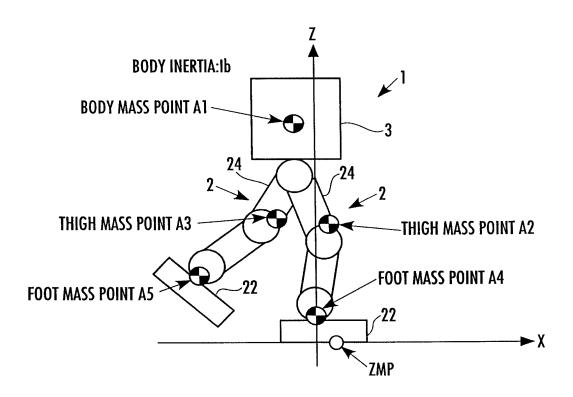
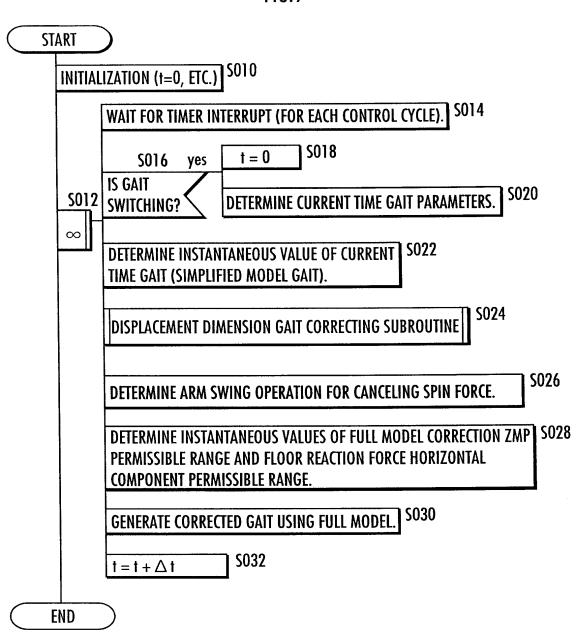


FIG.8



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FIG.9



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## **FIG.10**

#### **ENTRY**

**S100** DETERMINE 1ST PROVISIONAL CORRECTED BODY POSITION/POSTURE (Pb21,  $\, heta$  b21) Such that CONDITION 1 RELATED TO CENTER-OF-GRAVITY BETWEEN 1ST DISPLACEMENT DIMENSION CORRECTING MODEL AND 2ND DISPLACEMENT DIMENSION CORRECTING MODEL AND CONDITION 2 RELATED TO ANGULAR MOMENTUM PRODUCT ARE SATISFIED. 15102 WITH BODY POSTURE SET TO BE THE SAME AS THAT OF SIMPLIFIED MODEL GAIT, DETERMINE 2ND PROVISIONAL CORRECTED BODY POSITION/POSTURE (Pb22,  $\theta$  b22) SUCH THAT CONDITION 2 RELATED TO ANGULAR MOMENTUM PRODUCT BETWEEN 1ST DISPLACEMENT DIMENSION CORRECTING MODEL AND 2ND DISPLACEMENT DIMENSION CORRECTING MODEL IS SATISFIED. \$104 wl aim=1 IF MOTION MODE IS RUNNING MODE; wl aim=0.5 IF MOTION MODE IS LOW FRICTION FLOOR SURFACE WALKING MODE; OR wl aim=0 FOR OTHER MOTION MODES. **S106** GRADUALLY APPROXIMATE WEIGHT wI TO wl\_aim. \$108 DETERMINE WEIGHT w2 ACCORDING TO THE FOLLOWING EXPRESSION: w2 = 1 - w1DETERMINE DISPLACEMENT DIMENSION CORRECTED BODY POSITION/POSTURE (Pb2,  $\theta$  b2) **S110 ACCORDING TO THE FOLLOWING EXPRESSIONS:** Pb2 = w1 \* Pb21 + w2 \* Pb22 $\theta$  b2 = w1 \*  $\theta$  b21 + w2 \*  $\theta$  b22

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**FIG.11** 

**ENTRY** 

DETERMINE MASS POINT POSITIONS AND BODY POSTURE OF 1ST DISPLACEMENT DIMENSION CORRECTING MODEL ON THE BASIS OF INSTANTANEOUS VALUES OF SIMPLIFIED MODEL GAIT AT CURRENT TIME 1.

**S202** 

DETERMINE INITIAL CANDIDATES (Pb21\_s,  $\Theta$  b21\_s) OF 1ST PROVISIONAL CORRECTED BODY POSITION/POSTURE ACCORDING TO THE FOLLOWING EXPRESSIONS ON THE BASIS OF 1ST PROVISIONAL CORRECTED BODY POSITION Pb21\_p, DESIRED BODY POSITION Pb\_p, 1ST PROVISIONAL CORRECTED BODY POSTURE  $\Theta$  b21\_p, and desired body posture  $\Theta$  b\_p at last time t- $\triangle$ t, and desired body position Pb and desired body posture  $\Theta$  b at current time t.

Pb21\_s = Pb + (Pb21\_p—Pb\_p)  $\theta$  b21\_s=  $\theta$  b + ( $\theta$  b21\_p—  $\theta$  b\_p)

DETERMINE MASS POINT POSITIONS OF 2ND DISPLACEMENT DIMENSION CORRECTING MODEL ON THE BASIS OF CURRENT CANDIDATES (Pb21\_s,  $\Theta$  b21\_s) AND DESIRED POSITIONS/POSTURES OF BOTH FEET AT CURRENT TIME t.

**S206** 

DETERMINE OVERALL CENTER-OF-GRAVITY ERROR GC\_err AND ANGULAR MOMENTUM PRODUCT ERROR L\_err between 1st displacement dimension correcting model and 2nd displacement dimension correcting model.

**S208** 

**S210** yes

LEAVE REPETITION LOOP.

**S212** 

S204 I

ARE Gc\_err AND L\_err WITHIN PERMISSIBLE RANGES?

**S214** 

 $\infty$ 

DETERMINE A PLURALITY OF CANDIDATES (Pb21\_s+ $\triangle$  Pb21x,  $\theta$  b21\_s), (Pb21\_s+ $\triangle$  Pb21z,  $\theta$  b21\_s) AND (Pb21\_s,  $\theta$  b21\_s+ $\triangle$  Pb21z,  $\theta$  b21\_s) NEAR (Pb21\_s,  $\theta$  b21\_s), THEN USE THEM AS 1ST PROVISIONAL CORRECTED BODY POSITION/POSTURE CANDIDATES TO DETERMINE OVERALL CENTER-OF-GRAVITY ERROR AND ANGULAR MOMENTUM PRODUCT ERROR AS DESCRIBED ABOVE.

BASED ON OVERALL CENTER-OF-GRAVITY ERROR AND ANGULAR MOMENTUM PRODUCT ERROR ASSOCIATED WITH (Pb21\_s,  $\Theta$  b21\_s) and candidates in the vicinity thereof, determine new 1st provisional corrected body position/posture candidates (Pb21\_s,  $\Theta$  b21\_s) so as to approximate the errors to zero.

S216

SUBSTITUTE CURRENT (Pb21\_s,  $\theta$  b21\_s) INTO 1ST PROVISIONAL CORRECTED BODY POSITION/POSTURE (Pb21,  $\theta$  b21) at current time t.

S218

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### **FIG.12**

#### **ENTRY**

DETERMINE MASS POINT POSITIONS AND BODY POSTURE OF 1ST DISPLACEMENT DIMENSION CORRECTING \$300 MODEL ON THE BASIS OF INSTANTANEOUS VALUES OF SIMPLIFIED MODEL GAIT AT CURRENT TIME 1.

DETERMINE INITIAL CANDIDATES (Pb22\_s,  $\theta$  b22\_s) of 2nd provisional corrected BODY POSITION/POSTURE ACCORDING TO THE FOLLOWING EXPRESSIONS ON THE BASIS OF 2ND PROVISIONAL CORRECTED BODY POSITION Pb22 p AND DESIRED BODY POSITION Pb p AT LAST TIME t- \( \Delta \) t, AND DESIRED BODY POSITION Pb AND DESIRED BODY POSTURE  $\theta$  b at current time 1.

Pb22 s = Pb + (Pb22 p - Pb p)

 $\theta$  b22 s=  $\theta$  b

**S306** 

**S302** 

DETERMINE MASS POINT POSITIONS OF 2ND DISPLACEMENT DIMENSION CORRECTING MODEL ON THE BASIS OF CURRENT CANDIDATES (Pb22 s,  $\theta$  b22 s) and desired positions/postures OF BOTH FEET AT CURRENT TIME t.

DETERMINE ANGULAR MOMENTUM PRODUCT ERROR L  $\,$  err between 1st displacement DIMENSION CORRECTING MODEL AND 2ND DISPLACEMENT DIMENSION CORRECTING MODEL **S308** 

**S310** yes

LEAVE REPETITION LOOP.

**S312** 

**S304** 

 $\infty$ 

IS L\_err WITHIN PERMISSIBLE RANGE? -

**S314** 

DETERMINE A PLURALITY OF CANDIDATES (Pb22 s+  $\triangle$  Pb22x,  $\theta$  b22 s) and (Pb21\_s+  $\triangle$  Pb22z,  $\theta$  b22\_s) NEAR (Pb22\_s,  $\theta$  b22\_s), Then use them as 2nd provisional CORRECTED BODY POSITION/POSTURE CANDIDATES TO DETERMINE ANGULAR MOMENTUM PRODUCT

ERROR AS DESCRIBED ABOVE.

BASED ON ANGULAR MOMENTUM PRODUCT ERROR ASSOCIATED WITH (Pb22\_s,  $\theta$  b22\_s) AND CANDIDATES IN THE VICINITY THEREOF, DETERMINE NEW 2ND PROVISIONAL CORRECTED BODY POSITION/POSTURE CANDIDATES (Pb22 s,  $\theta$  b22\_s) so as to approximate THE ERROR TO ZERO. HOWEVER,  $\Theta$  b22  $\,$ s is not changed.

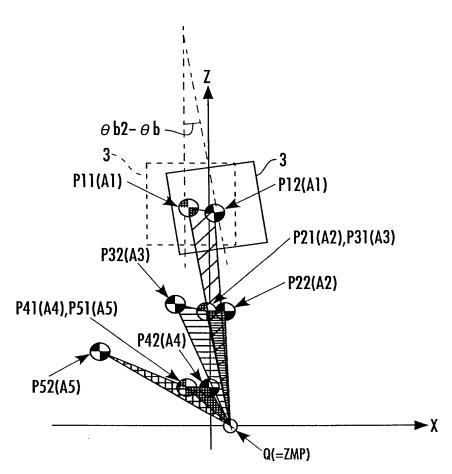
S316

SUBSTITUTE CURRENT (Pb22\_s,  $\theta$  b22\_s) INTO 2ND PROVISIONAL CORRECTED BODY POSITION/POSTURE (Pb22,  $\theta$  b22) AT CURRENT TIME t.

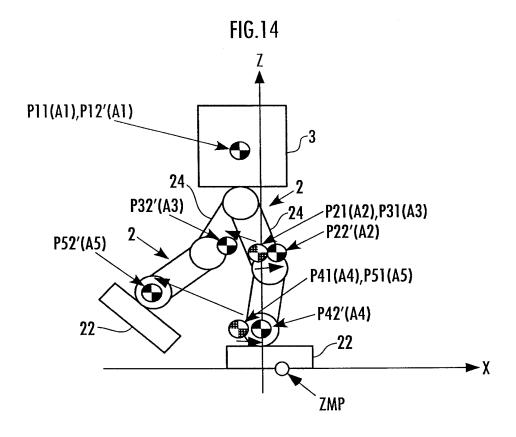
**S318** 

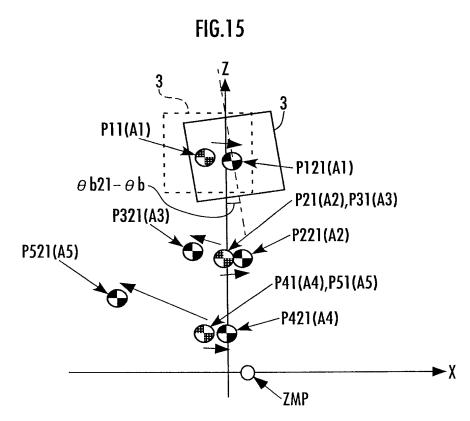
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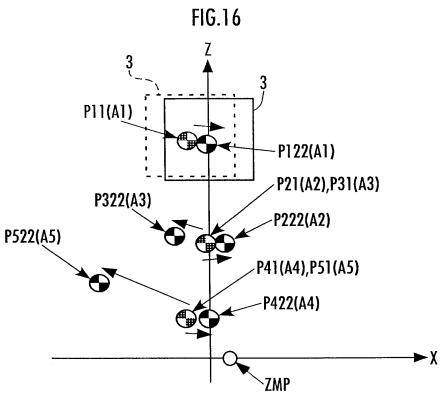


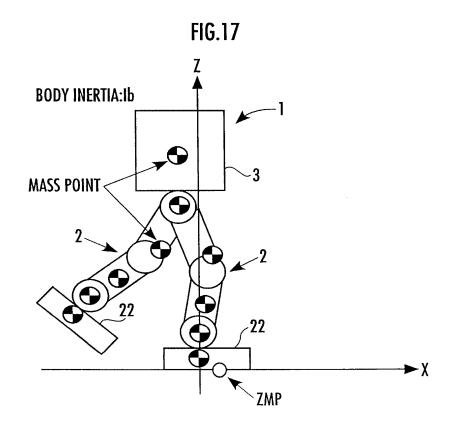
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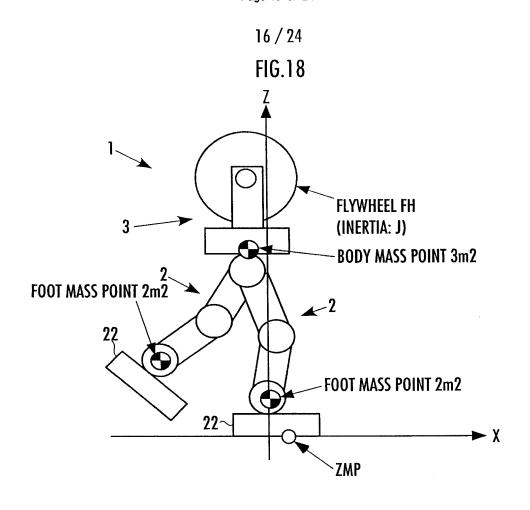


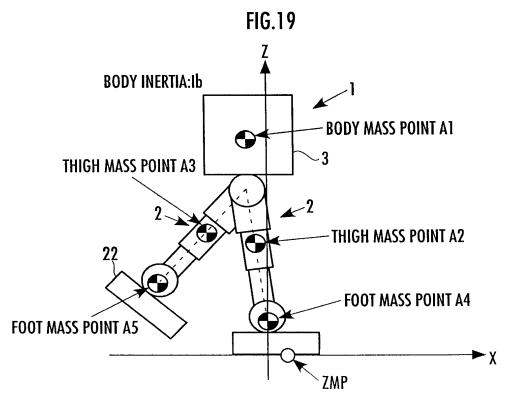
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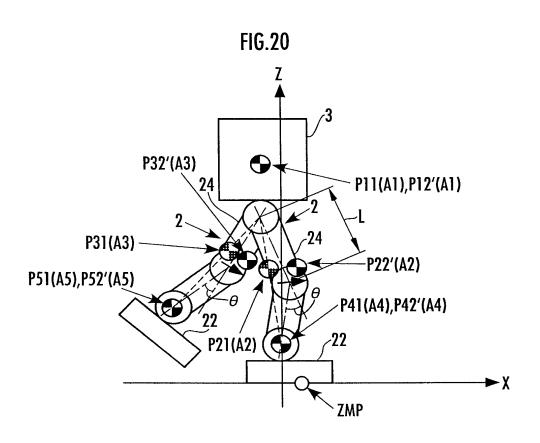


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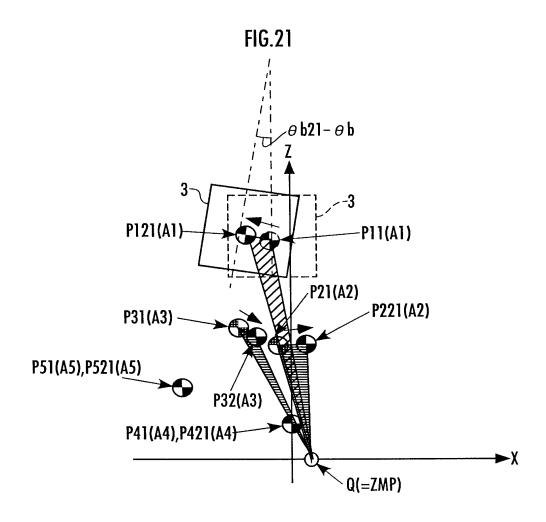




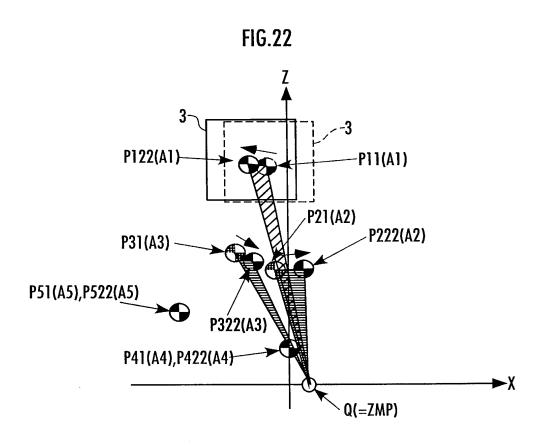
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## **FIG.23**

#### **ENTRY**

\$500 DETERMINE 1ST PROVISIONAL CORRECTED BODY POSITION/POSTURE (Pb21,  $\theta$  b21) Such that CONDITION 1 RELATED TO CENTER-OF-GRAVITY BETWEEN 1ST DISPLACEMENT DIMENSION CORRECTING MODEL AND 2ND DISPLACEMENT DIMENSION CORRECTING MODEL AND CONDITION 2 RELATED TO ANGULAR MOMENTUM PRODUCT ARE SATISFIED. \$502 wl\_aim=1 IF MOTION MODE IS RUNNING MODE; wl aim=0.5 IF MOTION MODE IS LOW FRICTION FLOOR SURFACE WALKING MODE; OR wl aim=0 FOR OTHER MOTION MODES. \$504 GRADUALLY APPROXIMATE WEIGHT wI TO wl\_aim. \$506 DETERMINE WEIGHT w2 ACCORDING TO THE FOLLOWING EXPRESSION: w2 = 1 - w1\$508 WITH BODY POSTURE SET TO w1 \*  $\theta$  b21+w2 \*  $\theta$  b, determine 2ND Provisional Corrected BODY POSITION/POSTURE (Pb22,  $\theta$  b22) Such that condition 2 related to angular MOMENTUM PRODUCT BETWEEN 1ST DISPLACEMENT DIMENSION CORRECTING MODEL AND 2ND DISPLACEMENT DIMENSION CORRECTING MODEL IS SATISFIED. **S510** DETERMINE DISPLACEMENT DIMENSION CORRECTED BODY POSITION/POSTURE (Pb2,  $\theta$  b2) ACCORDING TO THE FOLLOWING EXPRESSIONS. Pb2 = Pb22 $\theta$  b2 =  $\theta$  b22(=w1 \*  $\theta$  b21 + w2 \*  $\theta$  b)

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FIG.24

ENTRY

\$600

**S602** 

DETERMINE MASS POINT POSITIONS AND BODY POSTURE OF 1ST DISPLACEMENT DIMENSION CORRECTING MODEL ON THE BASIS OF INSTANTANEOUS VALUES OF SIMPLIFIED MODEL GAIT AT CURRENT TIME 1.

DETERMINE INITIAL CANDIDATES (Pb22\_s,  $\Theta$  b22\_s) OF 2ND PROVISIONAL CORRECTED BODY POSITION/POSTURE ACCORDING TO THE FOLLOWING EXPRESSIONS ON THE BASIS OF 2ND PROVISIONAL CORRECTED BODY POSITION Pb22\_p AND DESIRED BODY POSITION Pb\_p AT LAST TIME 1-  $\triangle$  1, AND DESIRED BODY POSITION Pb, DESIRED BODY POSTURE  $\Theta$  b, 1ST PROVISIONAL CORRECTED BODY POSTURE  $\Theta$  b21 AND WEIGHTS w1, w2 AT CURRENT TIME 1. Pb22 s = Pb + (Pb22 p—Pb p)

 $\theta$  b22 s= w1 \*  $\theta$  b21 + w2 \*  $\theta$  b

DETERMINE MASS POINT POSITIONS OF 2ND DISPLACEMENT DIMENSION CORRECTING MODEL ON THE BASIS OF CURRENT CANDIDATES (Pb22\_s,  $\Theta$  b22\_s) AND DESIRED POSITIONS/POSTURES OF BOTH FEET AT CURRENT TIME t.

\$606

DETERMINE ANGULAR MOMENTUM PRODUCT ERROR L\_err BETWEEN 1ST DISPLACEMENT DIMENSION CORRECTING MODEL AND 2ND DISPLACEMENT DIMENSION CORRECTING MODEL.

\$608

S610 yes

LEAVE REPETITION LOOP.

S612

5604 IS L\_err WITHIN PERMISSIBLE RANGE?

**S614** 

5616

DETERMINE A PLURALITY OF CANDIDATES (Pb22\_s+ $\triangle$  Pb22x,  $\theta$  b22\_s) and (Pb21\_s+ $\triangle$  Pb22z,  $\theta$  b22\_s) near (Pb22\_s,  $\theta$  b22\_s), then use them as 2nd provisional corrected body position/posture candidates to determine angular momentum product error as described above.

BASED ON ANGULAR MOMENTUM PRODUCT ERROR ASSOCIATED WITH (Pb22\_s,  $\theta$  b22\_s) and candidates in the vicinity thereof, determine New 2nd provisional corrected body Position/Posture candidates (Pb22\_s,  $\theta$  b22\_s) so as to approximate the error to zero. However,  $\theta$  b22\_s is not changed.

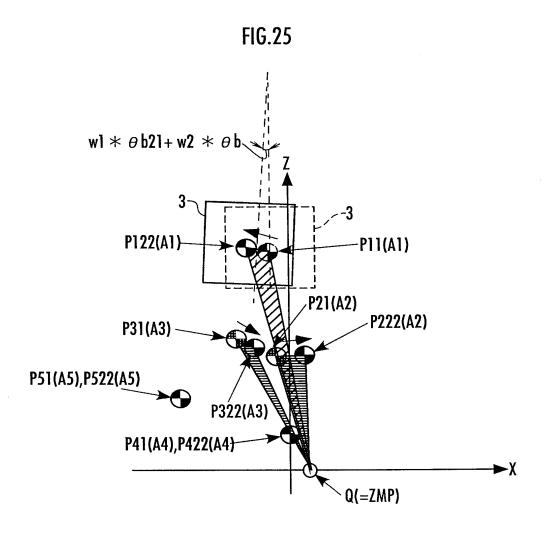
SUBSTITUTE CURRENT (Pb22\_s,  $\Theta$  b22\_s) INTO 2ND PROVISIONAL CORRECTED BODY POSITION/POSTURE (Pb22,  $\Theta$  b22) at current time t.

**S618** 

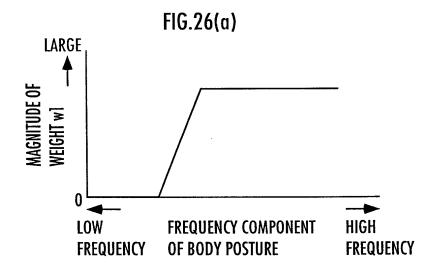
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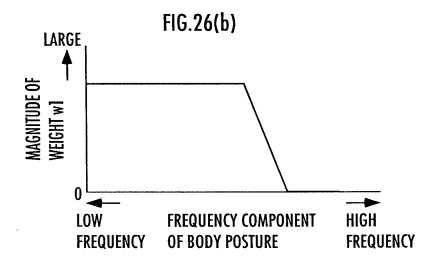
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# **FIG.27**

